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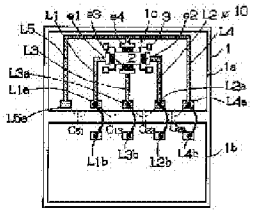
(54) ANGULAR VELOCITY SENSOR DEVICE



(57)Abstract:

PROBLEM TO BE SOLVED: To provide an angular velocity sensor device which can amplify only angular velocity signals at a high amplification rate by canceling out crosstalk voltages generated via parasitic capacities and can thus enhance the sensitivity of an angular velocity sensor.

SOLUTION: An angular velocity sensor device 10 comprises a sensing part 1a

and a signal processing circuit part 1b. Drive wiring L1, L2 is brought out to driving terminals L1a, L2a from the driving electrodes e1, e2 of the angular velocity sensor 1c of the sensing part 1a. A detecting wiring pattern L3 is brought out from one detecting electrode e3 to a detecting terminal L3a. From the other detecting electrode e4, a detecting wiring pattern L4 and a compensating wiring pattern L5 are brought out, respectively, to a detecting terminal L4a and a guaranteeing terminal L5a. Parasitic capacities C51, C13, C32, C24 between the wiring patterns are made to satisfy the bridge parallel condition of C51.C32=C13.C24 to cancel out crosstalk appearing at the detecting terminals L3b, L4b.

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CLAIMS

[Claim(s)]

[Claim 1] From the drive electrode (e1, e2) of the pair which an angular-velocity sensor opposes, and the detection electrode (e3, e4) of a pair the drive terminal (L1a, L2a) of the pair formed in the side section of the sensing section, and a detection terminal (L3a --) The circuit pattern for a drive (L1, L2) and the circuit pattern for detection (L3, L4) are drawn by L4a, respectively. And it is the angular-velocity sensor by which the compensation circuit pattern (L5) linked to the circuit pattern for detection (L4) is prepared. Parasitic capacitance between a compensation circuit pattern (L5) and the 1st circuit pattern for a drive (L1) is set to C51. Parasitic capacitance between the 1st circuit pattern for a drive (L1) and the 1st circuit pattern for detection (L3) is set to C13. Set parasitic capacitance between the 1st circuit pattern for detection (L3), and the 2nd circuit pattern for a drive (L2) to C32, and parasitic capacitance between the 2nd circuit pattern for a drive (L2) and the 2nd circuit pattern for detection (L4) is set to C24. Angular-velocity sensor equipment with which said each circuit pattern is arranged so that a bottom type may be materialized.

C51 and C32=C13, and C24 -- [Claim 2] From the drive electrode (e1, e2) of the pair which an angular-velocity sensor opposes, and the detection electrode (e3, e4) of a pair the drive terminal (L8a, L9a) of the pair formed in the same **** of the sensing section, and the detection terminal (L6a --) of a pair The circuit pattern for a drive (L8, L9) and the circuit pattern for detection (L6, L7) are drawn

by L7a, respectively. And it is the angular-velocity sensor by which the compensation circuit pattern (L5f) linked to the circuit pattern for detection (L9) is prepared. Parasitic capacitance between a compensation circuit pattern (L5f) and the 1st circuit pattern for detection (L6) is set to C56. Parasitic capacitance between the 1st circuit pattern for detection (L6) and the 1st circuit pattern for a drive (L8) is set to C68. Set parasitic capacitance between the 1st circuit pattern for a drive (L8), and the 2nd circuit pattern for detection (L7) to C87, and parasitic capacitance between the 2nd circuit pattern for detection (L7) and the 2nd circuit pattern for a drive (L9) is set to C79. Angular-velocity sensor equipment with which said each circuit pattern is arranged so that a bottom type may be materialized.

C56 and C87=C68, C79

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the angular-velocity sensor equipment which offset the cross talk of the driving signal from the circuit pattern for a drive to the circuit pattern for detection.

[0002]

[Description of the Prior Art] In recent years, small angular-velocity sensor equipment is used for the navigation system of an automobile, a robot's attitude control equipment, the hand deflection arrester of a camera, etc. The structure of this conventional angular-velocity sensor equipment is explained with reference to drawing 4 . The SOI (Silicon On Insulator) substrate 1 is processed, and angular-velocity sensor equipment 20 is formed, as shown in drawing 6 . This SOI substrate 1 consists of a three-tiered structure of the insulating layers s2, such as up silicon s1 and silicon oxide, and lower silicon s3, although processing is already added. Digital-disposal-circuit section 1b is formed in the SOI substrate 1 near sensing section 1a and this sensing section 1a.

[0003] Angular-velocity sensor 1c is arranged in the core of this sensing section 1a. This angular-velocity sensor 1c is explained with reference to drawing 5 and drawing 6 . The rectangular oscillating object 2 is supported by the support electrode 3 possible [vibration] through supporting beam 2a of the L character mold combined with four corners. In the both-ends side of the longitudinal direction of this oscillating object 2, two or more movable electrode 2bs and 2c are formed in the end face and the direction of a right angle, respectively. Moreover, two or more movable electrodes 2d and 2e are formed also in the both-sides side of the direction of a short hand of the oscillating object 2 in the side face and the direction of a right angle, respectively.

[0004] Movable electrode 2b and the drive electrodes e1 and e2 of Kushigata which gear with 2c through a gap, respectively are formed in the longitudinal direction of the oscillating object 2. Moreover, the detection electrodes e3 and e4 of Kushigata which gear with movable electrodes 2d and 2e through a gap, respectively are formed in the direction of a short hand of the oscillating object 2. And in this angular-velocity sensor 1c, each electrostatic capacity between the detection electrodes e3 and e4 and the drive electrodes e1 and e2 has taken the balance. As shown in drawing 6 , on the SOI substrate 1, the configuration of angular-velocity sensor 1c shown in drawing 5 is formed in the configuration

which shows a photoresist mask to drawing 5 , and is formed by etching the up silicon s1 of the SOI substrate 1 by RIE (Reacve Ion Etching) using 6 sulfur-fluoride (SF6) gas.

[0005] Moreover, as shown in drawing 5 and drawing 6 , etching removal of the insulating layer s2 of those lower parts and near is carried out, Gap g is formed between lower silicon s3, and free oscillation of the oscillating object 2 shown in a point-set part, supporting beam 2a, and movable electrode 2b - 2e is attained.

[0006] As shown in drawing 4 , the drive electrodes e1 and e2 are connected to drive terminal L1a and L2a which were formed in the one side section of sensing section 1a through the circuit patterns L1 and L2 for a drive, respectively. Moreover, the detection electrodes e3 and e4 are similarly connected to detection terminal L3a and L4a which were formed in said one side section through the circuit patterns L3 and L4 for detection, respectively. And parasitic capacitance will be formed between circuit patterns of such terminal arrangement.

[0007] In this case, one circuit pattern L3 for detection by the side of detection is formed in the shape of a straight line. The circuit patterns L1 and L2 of a driving side are crooked once, respectively, and are mostly arranged to the circuit pattern L3 for detection at axial symmetry. And the parasitic capacitance C13 between detection terminal L3a and drive terminal L1a is equal to the parasitic capacitance C32 between detection terminal L3a and drive terminal L2a.

[0008] Moreover, there is one circuit pattern L4 for detection which will be accepted a detection side in the opposite side of digital-disposal-circuit section 1b, it is crooked twice, turns around the outside of the circuit pattern L2 for a drive, and is drawn by detection terminal L4a. Therefore, the parasitic capacitance C14 to drive terminal L1a and the parasitic capacitance C24 to drive terminal L2a are different. This is because it is so small that it is not necessary to separate distantly [circuit pattern / L1 / for a drive] and the parasitic capacitance between those circuit patterns does not need to take into consideration to the circuit pattern L4 for detection being close to the circuit pattern L2 for a drive, and the parasitic capacitance between those circuit patterns becoming large.

[0009] On the other hand, digital-disposal-circuit section 1b integrated circuit (IC) Turns, and has four input/output terminals. That is, it is input terminal L4b of the capacity and the electrical-potential-difference conversion circuit connected to input terminal L3b of the capacity and the electrical-potential-difference conversion circuit connected to output terminal L1b of the driving signal oscillator circuit connected to drive terminal L1a, and detection terminal L3a, output terminal L2b of the driving signal oscillator circuit connected to drive terminal L2a, and detection terminal L4a.

[0010] Below, actuation of conventional angular-velocity sensor equipment 20 is explained. From drive terminal L1a of digital-disposal-circuit section 1b, and L2a, as a continuous line and a broken line show to drawing 7 , the alternating voltage of the this amplitude and sine wave from which about 180 degrees of phases of like-pole nature differ on the oscillation frequency of 10kHz is impressed between drive terminal L1a, L2a, and the support electrode 3 (gland), respectively.

[0011] Then, the oscillating object 2 comes to vibrate to a longitudinal direction. Thus, if angular-velocity sensor 1c rotates focusing on a medial axis perpendicular to space while the oscillating object 2 is vibrating, the oscillating object 2 will come to vibrate in the direction of a short hand by Coriolis force. And the electrostatic capacity formed between the detection electrodes e3 and e4 and the movable electrodes 2d and 2e of the oscillating object 2 increases one side, and another side comes to decrease in number. The variation (output signal) of such electrostatic capacity is inputted into capacity and an electrical-potential-difference conversion circuit through input terminal L3b of digital-disposal-circuit section 1b, and L4b from detection terminal L3a and L4a. And the difference of the conversion electrical potential difference of these output signals is taken, this is amplified, and angular velocity is detected.

[0012]

[Problem(s) to be Solved by the Invention] However, in conventional angular-velocity sensor equipment 20, in one detection terminal L3a, through parasitic capacitance C13 and C32, as shown in drawing 8 , the alternating voltage

(driving signal) of drive terminal L1a and L2a appears as a cross talk electrical potential difference by electrostatic-capacity association. However, since this cross talk electrical potential difference is reversed polarity, it is offset by detection terminal L3a, and is set to 0V. In addition, R is high resistance which holds the potential of detection terminal L3a (input terminal L3b) to 0V.

[0013] On the other hand, in another detection terminal L4a, through parasitic capacitance C14 and C24, as shown in drawing 9 , the alternating voltage (driving signal) of drive terminal L1a and L2a appears as a cross talk electrical potential difference by electrostatic-capacity association. In this case, since parasitic capacitance C24 is larger than parasitic capacitance C14 and a cross talk electrical potential difference is also high, the electrical potential difference (VC24-VC14) of those difference will remain, without offsetting these cross talk electrical potential differences by detection terminal L4a. Since the electrical potential difference of this difference was very large compared with the angular-velocity signal component by Coriolis force, when it was inputted into capacity and an electrical-potential-difference conversion circuit through input terminal L3b of digital-disposal-circuit 1b, and L4b and was amplified in the differential amplifying circuit of the next step, that output voltage was reached and saturated in supply voltage, and it had the fault that an angular-velocity signal will also be distorted to coincidence.

[0014] Then, this invention can offset the cross talk electrical potential difference through the parasitic capacitance of a driving signal, can amplify only an angular-velocity signal with a high amplification factor, and aims at offering the angular-velocity sensor equipment which can raise the sensibility (output voltage to 1 degree/s) of an angular-velocity sensor.

[0015]

[Means for Solving the Problem] Invention according to claim 1 from the drive electrode (e1, e2) of the pair which an angular-velocity sensor opposes, and the detection electrode (e3, e4) of a pair the drive terminal (L1a, L2a) of the pair formed in the side section of the sensing section, and a detection terminal (L3a --

) The circuit pattern for a drive (L1, L2) and the circuit pattern for detection (L3, L4) are drawn by L4a, respectively. And it is the angular-velocity sensor by which the compensation circuit pattern (L5) linked to the circuit pattern for detection (L4) is prepared. Parasitic capacitance between a compensation circuit pattern (L5) and the 1st circuit pattern for a drive (L1) is set to C51. Parasitic capacitance between the 1st circuit pattern for a drive (L1) and the 1st circuit pattern for detection (L3) is set to C13. Set parasitic capacitance between the 1st circuit pattern for detection (L3), and the 2nd circuit pattern for a drive (L2) to C32, and parasitic capacitance between the 2nd circuit pattern for a drive (L2) and the 2nd circuit pattern for detection (L4) is set to C24. Said each circuit pattern is arranged so that a bottom type may be materialized.

[0016] C51 and C32=C13, and C24 -- according to this invention, the circuit patterns L1 and L2 for a drive, the circuit patterns L3 and L4 for detection, and the compensation circuit pattern L5 constitute the bridge circuit through the parasitic capacitance C51, C13, C32, and C24 during wiring. And the parasitism capacity factors C51/C13 and C24/C32 are a respectively equal value. Since it is contained in this also in C13=C32 and C51=C24 and the electrical potential difference of this amplitude guides to detection terminal L3a and L4a with reversed polarity through such parasitic capacitance in this case, this cross talk electrical potential difference is canceled by detection terminal L3a and L4a. Therefore, an output is not carried out for a cross talk electrical potential difference to capacity and an electrical-potential-difference conversion circuit.

[0017] Moreover, in the case of parasitic capacitance C13 !=C32 and C51 !=C24, the cross talk electrical potential difference of the reversed polarity through such parasitic capacitance is not canceled by detection terminal L3a and L4a, respectively. therefore -- detection terminal L3a and L4a -- respectively -- like-pole nature -- the difference of same electric potential -- an electrical potential difference will remain. such difference -- an electrical potential difference should pass capacity and an electrical-potential-difference conversion circuit -- it is canceled by inputting and carrying out a differential amplifier to the differential

amplifying circuit of the next step. Invention according to claim 2 from the drive electrode (e1, e2) of the pair which an angular-velocity sensor opposes, and the detection electrode (e3, e4) of a pair the drive terminal (L8a, L9a) of the pair formed in the same **** of the sensing section, and the detection terminal (L6a --) of a pair The circuit pattern for a drive (L8, L9) and the circuit pattern for detection (L6, L7) are drawn by L7a, respectively. And it is the angular-velocity sensor by which the compensation circuit pattern (L5f) linked to the circuit pattern for detection (L9) is prepared. Parasitic capacitance between a compensation circuit pattern (L5f) and the 1st circuit pattern for detection (L6) is set to C56. Parasitic capacitance between the 1st circuit pattern for detection (L6) and the 1st circuit pattern for a drive (L8) is set to C68. Set parasitic capacitance between the 1st circuit pattern for a drive (L8), and the 2nd circuit pattern for detection (L7) to C87, and parasitic capacitance between the 2nd circuit pattern for detection (L7) and the 2nd circuit pattern for a drive (L9) is set to C79. Said each circuit pattern is arranged so that a bottom type may be materialized.
C56 and C87=C68, and C79 -- this invention also makes arrangement of a drive terminal and a detection terminal a thing and reverse according to claim 1 at the circuit pattern for a drive and the circuit pattern list for detection which make arrangement of the drive electrode of an angular-velocity sensor, and a detection electrode a thing and reverse according to claim 1, and are drawn from these electrodes. Therefore, the compensation circuit pattern L5 is connected to the outside circuit pattern L9 for detection.
[0018] Also in arrangement of this circuit pattern, by satisfying the equilibrium condition of a bridge circuit like invention according to claim 1 By the differential amplifier of the output signal of the same electric potential which appears in detection terminal L6a of a pair, and L7a, and this amplitude The cross talk electrical potential difference of the driving signal which carries out electrostatic induction through parasitic capacitance from drive terminal L8a (circuit pattern L8 for a drive) and drive terminal L9a (circuit pattern L9 for a drive) is cancellable.
[0019]

[Embodiment of the Invention] Below, the example of this invention is explained with reference to drawing 1 . Since this invention relates to amelioration of conventional angular-velocity sensor equipment, it is made to use the matter explained in drawing 4 - drawing 8 , gives the same number to the same part, and omits the explanation. In drawing 1 , the end is connected to the detection electrode e4 and the circuit pattern L4 for detection, it is crooked halfway, and L5 is a compensation circuit pattern and it is connected [the other end adjoins drive terminal L1a, and] to compensation terminal L5a formed in the same side section as it.

[0020] One circuit pattern L3 for detection is in the location of the axial symmetry of the circuit patterns L1 and L2 for a drive of a pair. Moreover, another circuit pattern L4 for detection and the compensation circuit pattern L5 are arranged so that the circuit patterns L1 and L2 for a drive may be enclosed, and they have the arrangement relation of axial symmetry to one circuit pattern L3 for detection. Therefore, another circuit pattern L4 for detection and the compensation circuit pattern L5, and the circuit patterns L1 and L2 for a drive of a pair have the arrangement relation which carried out identitas of the symmetry line of axial symmetry.

[0021] Therefore, the parasitic capacitance C24 between detection terminal L4a and drive terminal L2a becomes equal to the parasitic capacitance C51 between drive terminal L1a and compensation terminal L5a. Therefore, the relation between parasitic capacitance C13=C32 and C51=C24 is materialized, and in drawing 8 , it becomes equal, and the absolute value of the cross talk electrical potential difference of the reversed polarity through parasitic capacitance C13 and C32, i.e., the cross talk electrical potential difference of a driving signal, is offset in detection terminal L3a, and is set to 0V. Moreover, in drawing 10 , it becomes equal, and the absolute value of the cross talk electrical potential difference of the reversed polarity through parasitic capacitance C51 and C24 is also offset in detection terminal L4a, and is set to 0V.

[0022] Therefore, it is not necessary to take the differential amplifier of the output

signal of detection terminal L3a of a pair, and L4a, and a cross talk electrical potential difference can be canceled by making said parasitic capacitance equal in the latter part.

[0023] In the above, even if it is the case of parasitic capacitance C51 !=C24 and C13 !=C32 as shown in drawing 11 although an example in case parasitic capacitance C13=C32 and C51=C24 are materialized was explained, it connects with the circuit patterns L1 and L2 for a drive and the circuit patterns L3 and L4 for detection, and the compensation circuit pattern L5, and such parasitic capacitance constitutes the bridge circuit, as shown in drawing 2 . Therefore, if the equilibrium condition 13 of this bridge circuit, i.e., C51 and C32=C, and C24 are generally materialized, since a cross talk electrical potential difference will serve as inphase Doshisha University in detection terminal L3a and L4a of a pair, these cross talk electrical potential differences can be offset by letting a latter differential amplifying circuit pass.

[0024] In addition, in the above-mentioned example, since the compensation circuit pattern L5 and compensation terminal L5a have the function of the dummy electrode which forms parasitic capacitance C51, as long as C51 and C32=C13, and the conditions of C24 are acquired, what kind of configuration is sufficient as them, although formed in the configurations of the circuit pattern L4 for detection and detection terminal L4a, and axial symmetry.

[0025] Below, other examples are explained with reference to drawing 3 .

[0026] In the above-mentioned example, to the one side of sensing section 1a close to digital-disposal-circuit section 1b, the drive electrodes e1 and e2 of the pair of angular-velocity sensor 1c were formed in the parallel direction, and the detection electrodes e3 and e4 of a pair are formed in the direction which intersects perpendicularly.

[0027] As shown in drawing 3 , the orientation of the drive electrodes e1 and e2 of these pairs and the detection electrodes e3 and e4 of a pair may be replaced, respectively, for example, may be rotated 90 degrees counterclockwise. In this case, the circuit pattern L8 for a drive is drawn from the drive electrode e1 by

drive terminal L8a. The circuit pattern L9 for a drive and compensation circuit pattern L5f are drawn from the drive electrode e2 by drive terminal L9a and compensation terminal L5g, respectively. The circuit pattern L7 for detection is drawn from the detection electrode e3 by detection terminal L7a, and circuit pattern L6 for detection is drawn from the detection electrode e4 by detection terminal L6a.

[0028] And parasitic capacitance between compensation circuit pattern L5f (compensation terminal L5g) and circuit pattern L6 for a drive (detection terminal L6a) is set to C56. Parasitic capacitance between circuit pattern L6 for detection (detection terminal L6a) and the circuit pattern L8 (drive terminal L8a) for a drive is set to C68. Parasitic capacitance between the circuit pattern L8 (drive terminal L8a) for a drive and the circuit pattern L7 (detection terminal L7a) for detection is set to C87. Using parasitic capacitance between the circuit pattern L7 (detection terminal L7a) for detection, and the circuit pattern L9 (drive terminal L9a) for a drive as C79, said each circuit pattern is arranged so that a bottom type may be materialized.

C56 and C87=C68, C79 [0029]

[Effect of the Invention] Invention according to claim 1 connects a compensation circuit pattern to one circuit pattern for detection. The ratio of two parasitic capacitance formed between one circuit pattern for a drive, one circuit pattern for detection, and a compensation circuit pattern, The ratio of two parasitic capacitance formed between other circuit patterns for a drive, and the circuit pattern for detection of a pair, The cross talk electrical potential difference which makes it equal and appears in the detection terminal of a pair through parasitic capacitance can be made equal, and a cross talk electrical potential difference can be canceled, without [letting a latter differential amplifying circuit pass or] letting it pass. Thereby, only an angular-velocity signal can be amplified with a high amplification factor, and the sensibility of an angular-velocity sensor can be improved.

[0030] Invention according to claim 2 leaves arrangement of the compensation

circuit pattern in invention according to claim 1 as it is, and replaces arrangement of the circuit pattern for a drive of a pair, and the circuit pattern for detection of a pair. Also in this case, an operation of an angular-velocity sensor, a function, and effectiveness become being the same as that of invention according to claim 1.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The flat-surface gestalt Fig. of one example of the angular-velocity sensor equipment of this invention
[Drawing 2] The explanatory view of the bridge circuit formed of the parasitic capacitance between the circuit patterns of the sensing section of the angular-velocity sensor equipment shown in drawing 1
[Drawing 3] The explanatory view of the bridge circuit formed of the parasitic capacitance between the circuit patterns of the sensing section in other examples of the angular-velocity sensor equipment of this invention
[Drawing 4] The flat-surface gestalt Fig. of conventional angular-velocity sensor equipment
[Drawing 5] The expansion top view of the angular-velocity sensor shown in

drawing 1 and drawing 4

[Drawing 6] X-X-ray cross-section gestalt Fig. of drawing 5

[Drawing 7] The phase explanatory view of driver voltage

[Drawing 8] The explanatory view of the cross talk electrical potential difference through the parasitic capacitance in one detection terminal

[Drawing 9] The explanatory view of the cross talk electrical potential difference through the parasitic capacitance in other detection terminals

[Drawing 10] The explanatory view of the cross talk electrical potential difference which similarly minds the parasitic capacitance in other detection terminals

[Drawing 11] The explanatory view of the cross talk electrical potential difference through the parasitic capacitance in the detection terminal of a pair

[Description of Notations]

1 SOI Substrate

1a Sensing section

1b Digital-disposal-circuit section

1c Angular-velocity sensor

2 Oscillating Object

2a The supporting beam of a L character mold

2b-2e Movable electrode

3 Support Electrode

e1, e2 Drive electrode

e3, e4 Detection electrode

L1, L2, L8, L9 Circuit pattern for a drive

L3, L4, L6, L7 Circuit pattern for detection

L5, L5f Security circuit pattern

L1a, L2a, L8a, L9a Drive terminal

L3a, L4a, L6a, L7a Detection terminal

L5a, L5g Compensation terminal

10 Angular-Velocity Sensor Equipment

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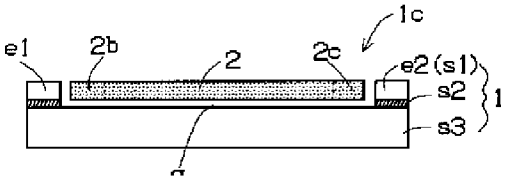
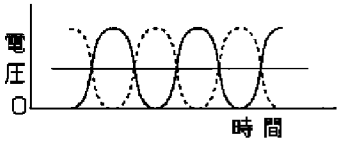
DRAWINGS

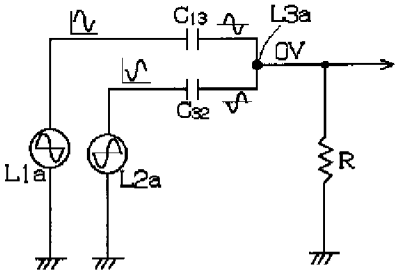
[Drawing 6]



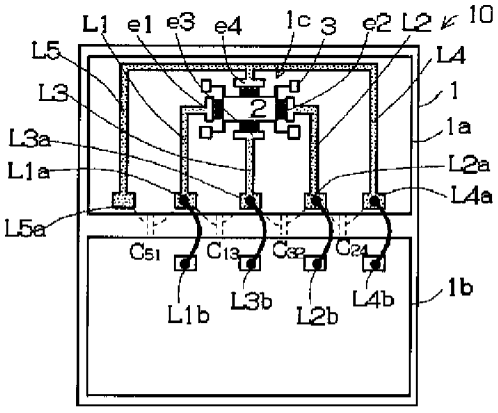
[Drawing 7]



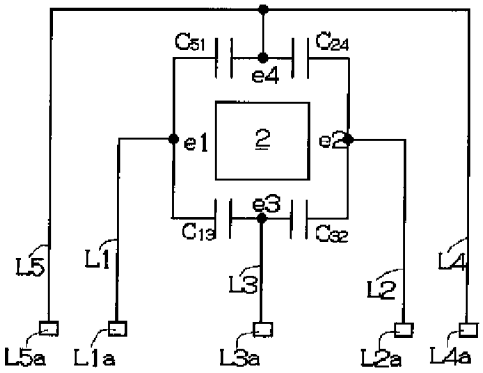
[Drawing 8]



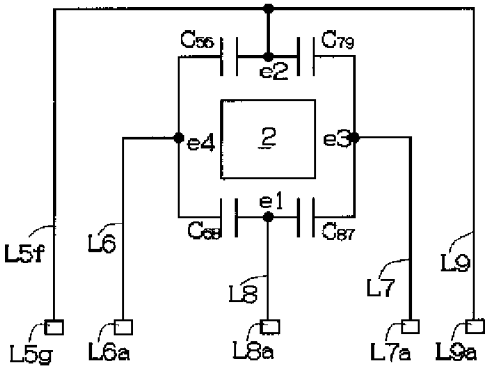
[Drawing 1]



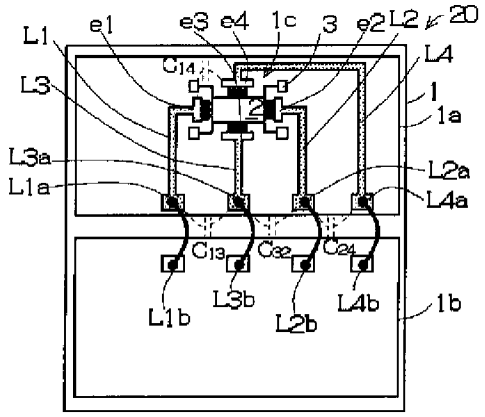
[Drawing 2]



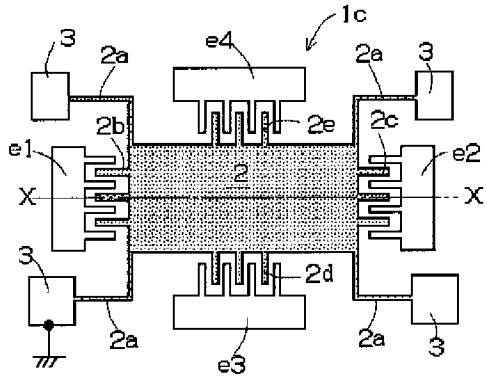
[Drawing 3]



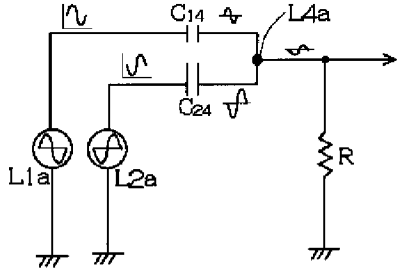
[Drawing 4]



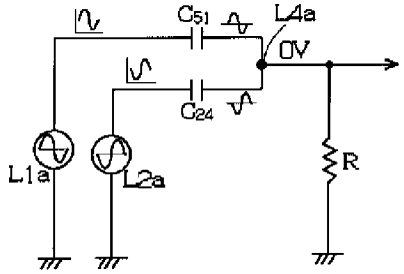
[Drawing 5]



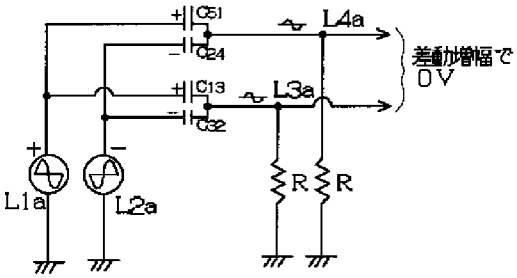
[Drawing 9]



[Drawing 10]



[Drawing 11]



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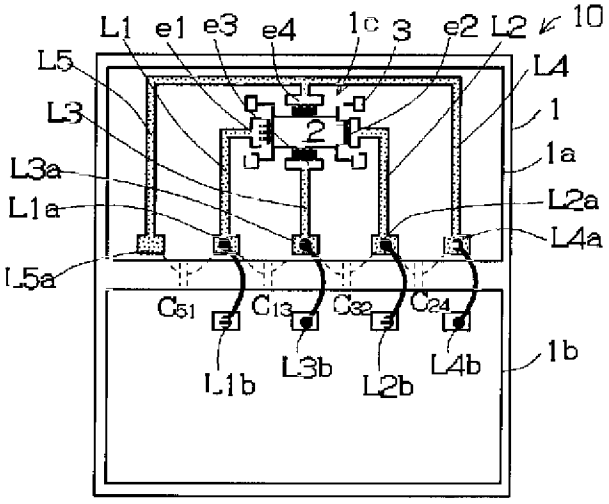
(54)【発明の名称】　角速度センサ装置

(57)【要約】
【課題】寄生容量を介するクロストーク電圧を相殺して、角速度信号のみを高い増幅率で増幅することができ、角速度センサの感度を向上させることのできる角速度センサ装置を提供する。
【解決手段】　センシング部１ａと信号処理回路部１ｂからなる。センシング部１ａの角速度センサ１ｃの駆動電極ｅ１、ｅ２からは駆動用配線Ｌ１、Ｌ２が駆動端子Ｌ１ａ、Ｌ２ａまで導出される。一つの検出電極ｅ３からは検出用配線パターンＬ３が検出端子Ｌ３ａまで導出される。もう一つの検出電極ｅ４からは、検出用配線パターンＬ４と補償配線パターンＬ５がそれぞれ検出端子Ｌ４ａ、保障端子Ｌ５ａまで導出される。そして、配線パターン間の寄生容量C_{51}、C_{13}、C_{32}、C_{24}に、$C_{51}\cdot C_{32}=C_{13}\cdot C_{24}$のブリッジ平行条件を満足させることにより、検出端子Ｌ３ｂ、Ｌ４ｂに現れるクロストークを相殺する。



【特許請求の範囲】
【請求項１】　角速度センサの対抗する一対の駆動電極（ｅ１、ｅ２）および一対の検出電極（ｅ３、ｅ４）から、センシング部の辺部に形成された一対の駆動端子（Ｌ１ａ、Ｌ２ａ）および検出端子（Ｌ３ａ、Ｌ４ａ）に、それぞれ駆動用配線パターン（Ｌ１、Ｌ２）および検出用配線パターン（Ｌ３、Ｌ４）が導出され、かつ、検出用配線パターン（Ｌ４）に接続する補償配線パターン（Ｌ５）が設けられている角速度センサであって、
補償配線パターン（Ｌ５）と第１の駆動用配線パターン（Ｌ１）との間の寄生容量をC_{51}とし、第１の駆動用配線パターン（Ｌ１）と第１の検出用配線パターン（Ｌ３）との間の寄生容量をC_{13}とし、第１の検出用配線パターン（Ｌ３）と第２の駆動用配線パターン（Ｌ２）との間の寄生容量をC_{32}とし、第２の駆動用配線パターン（Ｌ２）と第２の検出用配線パターン（Ｌ４）との間の寄生容量をC_{24}として、下式が成立するように、前記各配線パターンが配置されている角速度センサ装置。
$C_{51}・C_{32}＝C_{13}・C_{24}$
【請求項２】　角速度センサの対抗する一対の駆動電極（ｅ１、ｅ２）および一対の検出電極（ｅ３、ｅ４）から、センシング部の同一辺部に形成された一対の駆動端子（Ｌ８ａ、Ｌ９ａ）および一対の検出端子（Ｌ６ａ、Ｌ７ａ）に、それぞれ駆動用配線パターン（Ｌ８、Ｌ９）および検出用配線パターン（Ｌ６、Ｌ７）が導出され、かつ、検出用配線パターン（Ｌ９）に接続する補償配線パターン（Ｌ５ｆ）が設けられている角速度センサであって、
補償配線パターン（Ｌ５ｆ）と第１の検出用配線パターン（Ｌ６）との間の寄生容量をC_{56}とし、第１の検出用配線パターン（Ｌ６）と第１の駆動用配線パターン（Ｌ８）との間の寄生容量をC_{68}とし、第１の駆動用配線パターン（Ｌ８）と第２の検出用配線パターン（Ｌ７）との間の寄生容量をC_{87}とし、第２の検出用配線パターン（Ｌ７）と第２の駆動用配線パターン（Ｌ９）との間の寄生容量をC_{79}として、下式が成立するように、前記各配線パターンが配置されている角速度センサ装置。
$C_{56}・C_{87}＝C_{68}・C_{79}$
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、駆動用配線パターンから検出用配線パターンへの駆動信号のクロストークを相殺した角速度センサ装置に関する。
【０００２】
【従来の技術】近年、自動車のナビゲーションシステム、ロボットの姿勢制御装置、カメラの手振れ防止装置などに、小型の角速度センサ装置が使用されるようになっている。この従来の角速度センサ装置の構造について、図４を参照して説明する。角速度センサ装置２０は、図６に示すように、例えば、ＳＯＩ（Silicon On Insulator）基板１を加工して形成される。このＳＯＩ基板１は、既に加工が加えられているが、上部シリコンｓ１、酸化シリコンなどの絶縁層ｓ２および下部シリコンｓ３の３層構造よりなる。ＳＯＩ基板１には、センシング部１ａとこのセンシング部１ａの近傍に信号処理回路部１ｂが形成される。
【０００３】このセンシング部１ａの中心部には、角速度センサ１ｃが配置される。この角速度センサ１ｃについて、図５および図６を参照して説明する。長方形の振動体２は、４つの角部に結合するＬ字型の支持梁２ａを介してアンカー電極３に振動可能に支持されている。この振動体２の長手方向の両端面には、可動電極２ｂ、２ｃが端面と直角方向にそれぞれ複数個形成されている。また、振動体２の短手方向の両側面にも、可動電極２ｄ、２ｅが側面と直角方向にそれぞれ複数個形成されている。
【０００４】振動体２の長手方向には、可動電極２ｂ、２ｃとそれぞれ間隙を介して噛み合う櫛形の駆動電極ｅ１、ｅ２が形成されている。また、振動体２の短手方向には、可動電極２ｄ、２ｅとそれぞれ間隙を介して噛み合う櫛形の検出電極ｅ３、ｅ４が形成されている。そして、この角速度センサ１ｃにおいては、検出電極ｅ３、ｅ４と駆動電極ｅ１、ｅ２との間のそれぞれの静電容量は平衡が取れている。図５に示す角速度センサ１ｃの形状は、図６に示すように、ＳＯＩ基板１の上に、フォトレジストマスクを図５に示す形状に形成し、６フッ化硫黄（SF_6）ガスを用いたＲＩＥ（Reacve Ion Etching）によりＳＯＩ基板１の上部シリコンｓ１をエッチングすることにより形成される。
【０００５】また、図５および図６に示すように、点集合部分で示す振動体２、支持梁２ａ、可動電極２ｂ～２ｅは、それらの下部および近傍の絶縁層ｓ２がエッチング除去されて、下部シリコンｓ３との間に間隙ｇが形成され自由振動可能になっている。
【０００６】図４に示すように、駆動電極ｅ１、ｅ２は、それぞれ駆動用配線パターンＬ１、Ｌ２を介して、センシング部１ａの一つの辺部に形成された駆動端子Ｌ１ａ、Ｌ２ａに接続される。また、同様に、検出電極ｅ３、ｅ４は、それぞれ検出用配線パターンＬ３、Ｌ４を介して、前記一つの辺部に形成された検出端子Ｌ３ａ、Ｌ４ａにそれぞれ接続される。そして、このような端子配置により、配線パターン間に寄生容量が形成されることになる。
【０００７】この場合、検出側の一つの検出用配線パターンＬ３は直線状に形成されている。駆動側の配線パターンＬ１、Ｌ２は、それぞれ１回屈曲して、検出用配線パターンＬ３に対しほぼ線対称に配置されている。そして、検出端子Ｌ３ａと駆動端子Ｌ１ａとの間の寄生容量Ｃ１３が、検出端子Ｌ３ａと駆動端子Ｌ２ａとの間の寄生容量Ｃ３２に等しくなっている。

【０００８】また、検出側のもう一つの検出用配線パターンＬ４は、信号処理回路部１ｂの反対側にあって２回屈曲して、駆動用配線パターンＬ２の外側を回って検出端子Ｌ４ａに導出されている。したがって、駆動端子Ｌ１ａに対する寄生容量Ｃ１４と駆動端子Ｌ２ａに対する寄生容量Ｃ２４とが相違している。これは、検出用配線パターンＬ４が、駆動用配線パターンＬ２には近くて、それらの配線パターン間の寄生容量が大きくなるのに対し、駆動用配線パターンＬ１とは遠く離れて、それらの配線パターン間の寄生容量が考慮する必要がないほど小さいからである。

【０００９】一方、信号処理回路部１ｂは、集積回路（ＩＣ）化されて、４つの入出力端子を持っている。即ち、駆動端子Ｌ１ａに接続されている駆動信号発振回路の出力端子Ｌ１ｂ、検出端子Ｌ３ａに接続されている容量・電圧変換回路の入力端子Ｌ３ｂ、駆動端子Ｌ２ａに接続されている駆動信号発振回路の出力端子Ｌ２ｂおよび検出端子Ｌ４ａに接続されている容量・電圧変換回路の入力端子Ｌ４ｂである。

【００１０】つぎに、従来の角速度センサ装置２０の動作について説明する。信号処理回路部１ｂの駆動端子Ｌ１ａ、Ｌ２ａから、図７に実線と破線で示すように、１０ｋＨｚの発振周波数で同極性の１８０°位相の異なる、同振幅かつ正弦波の交流電圧をそれぞれ駆動端子Ｌ１ａ、Ｌ２ａとアンカー電極３（グランド）との間に印加する。

【００１１】すると、振動体２は、長手方向に振動するようになる。このように振動体２が振動しているときに、角速度センサ１ｃが紙面に垂直な中心軸を中心にして回転すると、振動体２はコリオリ力により短手方向に振動するようになる。そして、検出電極ｅ３、ｅ４と振動体２の可動電極２ｄ、２ｅとの間に形成される静電容量が、一方は増加し他方は減少するようになる。これらの静電容量の変化量（出力信号）が検出端子Ｌ３ａ、Ｌ４ａから信号処理回路部１ｂの入力端子Ｌ３ｂ、Ｌ４ｂを介して容量・電圧変換回路に入力される。そして、これらの出力信号の変換電圧の差をとり、これを増幅して角速度を検出する。

【００１２】

【発明が解決しようとする課題】しかしながら、従来の角速度センサ装置２０においては、一つの検出端子Ｌ３ａには、寄生容量Ｃ１３とＣ３２を介して、図８に示すように、駆動端子Ｌ１ａ、Ｌ２ａの交流電圧（駆動信号）が静電容量結合によるクロストーク電圧として現れる。しかし、このクロストーク電圧は逆極性なので、検出端子Ｌ３ａで相殺されて０Ｖとなる。なお、Ｒは検出端子Ｌ３ａ（入力端子Ｌ３ｂ）の電位を０Ｖに保持する高抵抗である。

【００１３】一方、もう一つの検出端子Ｌ４ａには、寄生容量Ｃ１４とＣ２４を介して、図９に示すように、駆動端子Ｌ１ａ、Ｌ２ａの交流電圧（駆動信号）が静電容量結合によるクロストーク電圧として現れる。この場合、寄生容量Ｃ２４が寄生容量Ｃ１４より大きく、クロストーク電圧も高いので、これらのクロストーク電圧は、検出端子Ｌ４ａで相殺されずに、それらの差分の電圧（$V_{C24}-V_{C14}$）が残ることになる。この差分の電圧は、コリオリ力による角速度信号成分に比べて非常に大きいので、信号処理回路１ｂの入力端子Ｌ３ｂ、Ｌ４ｂを介して容量・電圧変換回路に入力されて、次段の差動増幅回路で増幅されると、その出力電圧は電源電圧に達し、飽和してしまい、同時に角速度信号も歪んでしまうという欠点があった。

【００１４】そこで、本発明は、駆動信号の寄生容量を介するクロストーク電圧を相殺して、角速度信号のみを高い増幅率で増幅することができ、角速度センサの感度（１°／ｓに対する出力電圧）を向上させることのできる角速度センサ装置を提供することを目的とする。

【００１５】

【課題を解決するための手段】請求項１に記載の発明は、角速度センサの対抗する一対の駆動電極（ｅ１、ｅ２）および一対の検出電極（ｅ３、ｅ４）から、センシング部の辺部に形成された一対の駆動端子（Ｌ１ａ、Ｌ２ａ）および検出端子（Ｌ３ａ、Ｌ４ａ）に、それぞれ駆動用配線パターン（Ｌ１、Ｌ２）および検出用配線パターン（Ｌ３、Ｌ４）が導出され、かつ、検出用配線パターン（Ｌ４）に接続する補償配線パターン（Ｌ５）が設けられている角速度センサであって、補償配線パターン（Ｌ５）と第１の駆動用配線パターン（Ｌ１）との間の寄生容量をC_{51}とし、第１の駆動用配線パターン（Ｌ１）と第１の検出用配線パターン（Ｌ３）との間の寄生容量をC_{13}とし、第１の検出用配線パターン（Ｌ３）と第２の駆動用配線パターン（Ｌ２）との間の寄生容量をC_{32}とし、第２の駆動用配線パターン（Ｌ２）と第２の検出用配線パターン（Ｌ４）との間の寄生容量をC_{24}として、下式が成立するように、前記各配線パターンが配置されているものである。

【００１６】$C_{51}\cdot C_{32}=C_{13}\cdot C_{24}$

この発明によれば、駆動用配線パターンＬ１、Ｌ２、検出用配線パターンＬ３、Ｌ４および補償配線パターンＬ５は、配線間の寄生容量C_{51}、C_{13}、C_{32}、C_{24}、を介してブリッジ回路を構成している。そして、寄生容量比C_{51}/C_{13}とC_{24}/C_{32}がそれぞれ等しい値になっている。これには、$C_{13}=C_{32}$および$C_{51}=C_{24}$の場合も含まれ、この場合には、検出端子Ｌ３ａ、Ｌ４ａには、これらの寄生容量を介して逆極性で同振幅の電圧が誘導するので、このクロストーク電圧は検出端子Ｌ３ａ、Ｌ４ａでキャンセルされる。したがって、クロストーク電圧は容量・電圧変換回路には出力はされない。

【００１７】また、寄生容量$C_{13}\neq C_{32}$および$C_{51}\neq C_{24}$の場合には、これらの寄生容量を介する逆極性のクロ

ストーク電圧は、検出端子Ｌ３ａ、Ｌ４ａでそれぞれキャンセルされない。したがって、検出端子Ｌ３ａ、Ｌ４ａには、それぞれ同極性で同電位の差分電圧が残ることになる。これらの差分電圧は、容量・電圧変換回路を経て、次段の差動増幅回路に入力されて、差動増幅されることにより、キャンセルされる。請求項２に記載の発明は、角速度センサの対抗する一対の駆動電極（ｅ１、ｅ２）および一対の検出電極（ｅ３、ｅ４）から、センシング部の同一辺部に形成された一対の駆動端子（Ｌ８ａ、Ｌ９ａ）および一対の検出端子（Ｌ６ａ、Ｌ７ａ）に、それぞれ駆動用配線パターン（Ｌ８、Ｌ９）および検出用配線パターン（Ｌ６、Ｌ７）が導出され、かつ、検出用配線パターン（Ｌ９）に接続する補償配線パターン（Ｌ５ｆ）が設けられている角速度センサであって、補償配線パターン（Ｌ５ｆ）と第１の検出用配線パターン（Ｌ６）との間の寄生容量をC_{56}とし、第１の検出用配線パターン（Ｌ６）と第１の駆動用配線パターン（Ｌ８）との間の寄生容量をC_{68}とし、第１の駆動用配線パターン（Ｌ８）と第２の検出用配線パターン（Ｌ７）との間の寄生容量をC_{87}とし、第２の検出用配線パターン（Ｌ７）と第２の駆動用配線パターン（Ｌ９）との間の寄生容量をC_{79}として、下式が成立するように、前記各配線パターンが配置されているものである。

$C_{56}\cdot C_{87}=C_{68}\cdot C_{79}$

この発明は、角速度センサの駆動電極と検出電極の配置を、請求項１に記載のものと逆にし、かつ、これらの電極から導出される駆動用配線パターンおよび検出用配線パターン並びに駆動端子および検出端子の配置も、請求項１に記載のものと逆にしたものである。したがって、補償配線パターンＬ５が外側の検出用配線パターンＬ９に接続されている。

【００１８】この配線パターンの配置においても、請求項１に記載の発明と同様に、ブリッジ回路の平衡条件を成立させることにより、一対の検出端子Ｌ６ａ、Ｌ７ａに現れる同電位かつ同振幅の出力信号の差動増幅により、駆動端子Ｌ８ａ（駆動用配線パターンＬ８）、駆動端子Ｌ９ａ（駆動用配線パターンＬ９）から寄生容量を介して静電誘導する駆動信号のクロストーク電圧をキャンセルすることができる。

【００１９】

【発明の実施の形態】以下に、本発明の実施例について図１を参照して説明する。本発明は、従来の角速度センサ装置の改良に関するものなので、図４～図８において説明した事項を援用することにして、同一部分には同一番号を付して、その説明を省略する。図１において、Ｌ５は補償配線パターンで、その一端が検出電極ｅ４と検出用配線パターンＬ４に接続されて中途で屈曲し、その他端は駆動端子Ｌ１ａに隣接して、それと同じ辺部に形成された補償端子Ｌ５ａに接続されている。

【００２０】一つの検出用配線パターンＬ３は、一対の駆動用配線パターンＬ１、Ｌ２の線対称の位置にある。また、もう一つの検出用配線パターンＬ４および補償配線パターンＬ５は、駆動用配線パターンＬ１、Ｌ２を囲うように配置されており、一つの検出用配線パターンＬ３に対し、線対称の配置関係にある。したがって、もう一つの検出用配線パターンＬ４および補償配線パターンＬ５と一対の駆動用配線パターンＬ１、Ｌ２は、線対称の対称線を同一した配置関係にある。

【００２１】よって、検出端子Ｌ４ａと駆動端子Ｌ２ａとの間の寄生容量Ｃ２４は、駆動端子Ｌ１ａと補償端子Ｌ５ａとの間の寄生容量Ｃ５１と等しくなる。したがって、寄生容量Ｃ１３＝Ｃ３２およびＣ５１＝Ｃ２４の関係が成立し、図８において、寄生容量Ｃ１３、Ｃ３２を介する逆極性のクロストーク電圧、即ち駆動信号のクロストーク電圧の絶対値は等しくなり、検出端子Ｌ３ａにおいて相殺されて０Ｖとなる。また、図１０において、寄生容量Ｃ５１、Ｃ２４を介する逆極性のクロストーク電圧の絶対値も等しくなり、検出端子Ｌ４ａにおいて相殺されて０Ｖとなる。

【００２２】したがって、後段において、一対の検出端子Ｌ３ａ、Ｌ４ａの出力信号の差動増幅を取るまでもなく、前記寄生容量を等しくすることにより、クロストーク電圧をキャンセルすることができる。

【００２３】上記においては、寄生容量Ｃ１３＝Ｃ３２および$C_{51}=C_{24}$が成立する場合の一例について説明したが、図１１に示すように、寄生容量$C_{51}\neq C_{24}$および$C_{13}\neq C_{32}$の場合であっても、これらの寄生容量は、図２に示すように、駆動用配線パターンＬ１、Ｌ２および検出用配線パターンＬ３、Ｌ４、補償配線パターンＬ５に接続されて、ブリッジ回路を構成している。したがって、このブリッジ回路の平衡条件、即ち、$C_{51}\cdot C_{32}=C_{13}\cdot C_{24}$が一般的に成立すれば、一対の検出端子Ｌ３ａとＬ４ａにおいてクロストーク電圧は同相同大となるので、後段の差動増幅回路を通すことにより、これらのクロストーク電圧を相殺することができる。

【００２４】なお、上記実施例においては、補償配線パターンＬ５および補償端子Ｌ５ａは、検出用配線パターンＬ４および検出端子Ｌ４ａと線対称の形状に形成したが、寄生容量C_{51}を形成するダミー電極の機能を有するので、$C_{51}\cdot C_{32}=C_{13}\cdot C_{24}$の条件が得られれば、どのような形状でもよい。

【００２５】つぎに、他の実施例について図３を参照して説明する。

【００２６】上記実施例においては、信号処理回路部１ｂに近接するセンシング部１ａの一つの辺に対し、平行する方向に角速度センサ１ｃの一対の駆動電極ｅ１、ｅ２を設け、また直交する方向に一対の検出電極ｅ３、ｅ４を設けている。

【００２７】これらの一対の駆動電極ｅ１、ｅ２および一対の検出電極ｅ３、ｅ４の配置方向を、図３に示すよ

うに、それぞれ入れ替えて、例えば、反時計方向に９０°回転させてもよい。この場合、駆動電極ｅ１から駆動用配線パターンＬ８が駆動端子Ｌ８ａに導出され、駆動電極ｅ２から駆動用配線パターンＬ９と補償配線パターンＬ５ｆとがそれぞれ駆動端子Ｌ９ａと補償端子Ｌ５ｇとに導出され、検出電極ｅ３から検出用配線パターンＬ７が検出端子Ｌ７ａに導出され、検出電極ｅ４から検出用配線パターンＬ６が検出端子Ｌ６ａに導出されている。

【００２８】そして、補償配線パターンＬ５ｆ（補償端子Ｌ５ｇ）と駆動用配線パターンＬ６（検出端子Ｌ６ａ）との間の寄生容量をC_{56}とし、検出用配線パターンＬ６（検出端子Ｌ６ａ）と駆動用配線パターンＬ８（駆動端子Ｌ８ａ）との間の寄生容量をC_{68}とし、駆動用配線パターンＬ８（駆動端子Ｌ８ａ）と検出用配線パターンＬ７（検出端子Ｌ７ａ）との間の寄生容量をC_{87}とし、検出用配線パターンＬ７（検出端子Ｌ７ａ）と駆動用配線パターンＬ９（駆動端子Ｌ９ａ）との間の寄生容量をC_{79}として、下式が成立するように、前記各配線パターンが配置されている。

$C_{56}\cdot C_{87}=C_{68}\cdot C_{79}$

【００２９】

【発明の効果】請求項１に記載の発明は、一つの検出用配線パターンに補償配線パターンを接続して、一つの駆動用配線パターンと一つの検出用配線パターンおよび補償配線パターンとの間に形成される２つの寄生容量の比と、他の駆動用配線パターンと一対の検出用配線パターンとの間に形成される２つの寄生容量の比と、を等しくし、かつ、寄生容量を介して一対の検出端子に現れるクロストーク電圧を等しくして、後段の差動増幅回路を通すことにより、または通さずに、クロストーク電圧をキャンセルすることができる。これにより、角速度信号のみを高い増幅率で増幅することができ、角速度センサの感度を向上することができる。

【００３０】請求項２に記載の発明は、請求項１に記載の発明における補償配線パターンの配置はそのままにして、一対の駆動用配線パターンと一対の検出用配線パターンの配置を入れ替えたものである。この場合においても、角速度センサの作用、機能および効果は、請求項１に記載の発明と同様となる。

【図面の簡単な説明】

【図１】　本発明の角速度センサ装置の一実施例の平面形態図

【図２】　図１に示す角速度センサ装置のセンシング部の配線パターン間の寄生容量により形成されるブリッジ回路の説明図

【図３】　本発明の角速度センサ装置の他の実施例におけるセンシング部の配線パターン間の寄生容量により形成されるブリッジ回路の説明図

【図４】　従来の角速度センサ装置の平面形態図

【図５】　図１および図４に示す角速度センサの拡大平面図

【図６】　図５のＸ－Ｘ線断面形態図

【図７】　駆動電圧の位相説明図

【図８】　一つの検出端子における寄生容量を介するクロストーク電圧の説明図

【図９】　他の検出端子における寄生容量を介するクロストーク電圧の説明図

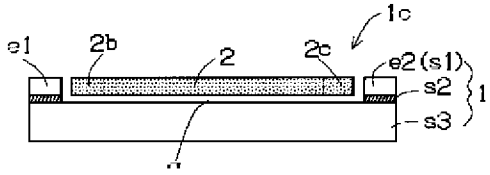
【図１０】　同じく、他の検出端子における寄生容量を介するクロストーク電圧の説明図

【図１１】　一対の検出端子における寄生容量を介するクロストーク電圧の説明図

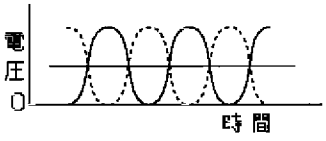
【符号の説明】

１	ＳＯＩ基板
１ａ	センシング部
１ｂ	信号処理回路部
１ｃ	角速度センサ
２	振動体
２ａ	Ｌ字型の支持梁
２ｂ～２ｅ	可動電極
３	アンカー電極
ｅ１、ｅ２	駆動電極
ｅ３、ｅ４	検出電極
Ｌ１、Ｌ２、Ｌ８、Ｌ９	駆動用配線パターン
Ｌ３、Ｌ４、Ｌ６、Ｌ７	検出用配線パターン
Ｌ５、Ｌ５ｆ	保障配線パターン
Ｌ１ａ、Ｌ２ａ、Ｌ８ａ、Ｌ９ａ	駆動端子
Ｌ３ａ、Ｌ４ａ、Ｌ６ａ、Ｌ７ａ	検出端子
Ｌ５ａ、Ｌ５ｇ	補償端子
１０	角速度センサ装置

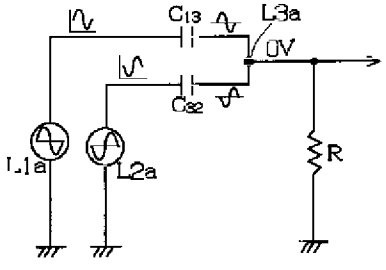
【図６】



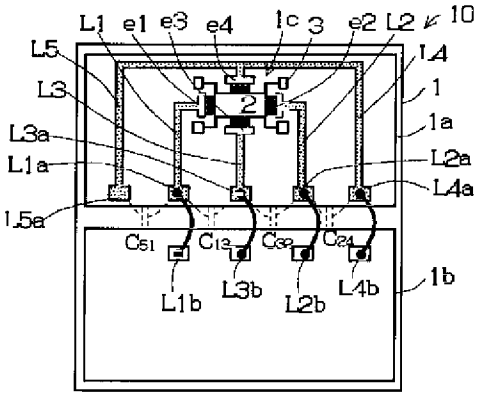
【図７】



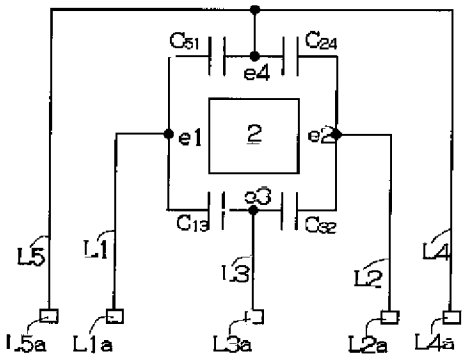
【図８】



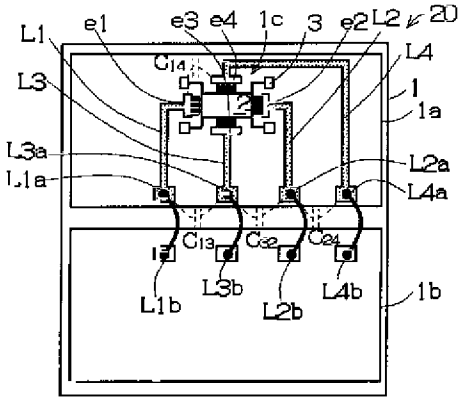
【図１】



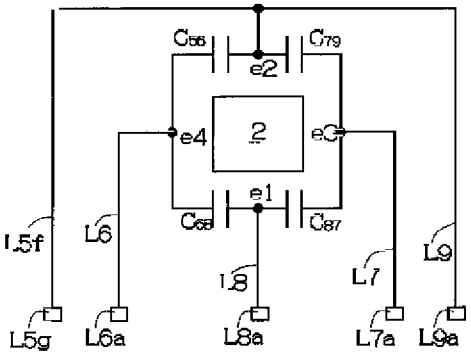
【図２】



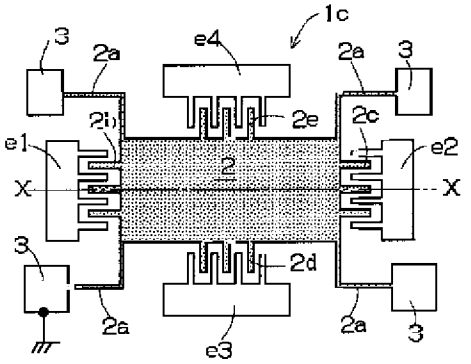
【図４】



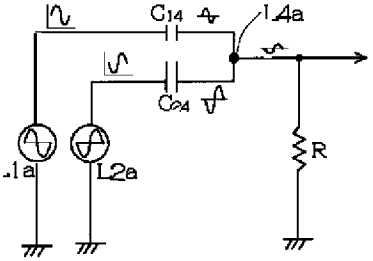
【図３】



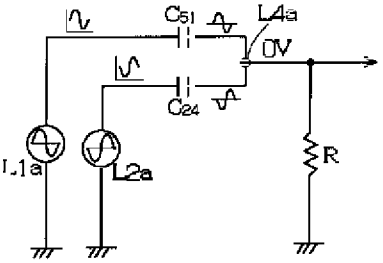
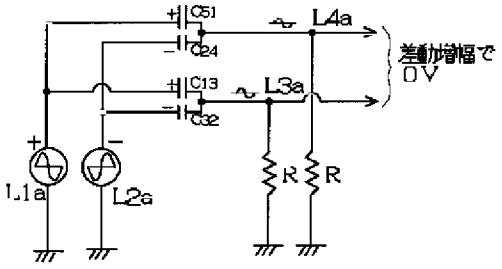
【図５】



【図９】



【図１０】



【図１１】